REMARKS

Claims 1, 3, 4, 6, 8 and 12 stand rejected under 35 USC 102(b) as being anticipated by or, in the alternative, under 35 USC 103(a) as obvious over Leumer. Claims 1, 2, 3, 6, 8 and 11 stand rejected under 35 USC 103(a) as being unpatentable over Tashiro. Claim 7 stands rejected under 35 USC 103(a) as being unpatentable over Leumer in view of Buxbaum. Claim 7 also stands rejected under 35 USC 103(a) as being unpatentable over Tashiro in view of Buxbaum. Claims 9 and 10 stand rejected under 35 USC 103(a) as being unpatentable over Tashiro in view of Vogt. Claims 9 and 10 also stand rejected under 35 USC 103(a) as being unpatentable over Leumer in view of Vogt. As explained below, Leumer, Tashiro, Buxbaum and Vogt, alone or in combination, fail to disclose or suggest the claimed polyester fiber including a phosphorus compound copolymerized polyester with a phosphorus atom in a side chain. The cited references also fail to disclose a polyester fiber possessing all of the claimed characteristics. Accordingly, these rejections are respectfully traversed.

In the Action, the Examiner agrees that Leumer and Tashiro do not explicitly teach several of the properties recited in claims 1, 3 and 6. The Examiner, however, contends that the polyesters in Leumer and Tashiro meet the requirements of formulas 4 and 5 in dependent claim 6 and, therefore, all of the claimed limitations in the independent claims would be inherent. The Examiner is incorrect since all of the claimed formulas measure different properties of the polyester, all of which are not directly related. Further, as described below, the claimed properties are properties of the fiber and not just a property of the polyester alone.

I. Examination of Claim 1

The technical meaning of each formula in claim 1 is as follows:

(a) $\tan \delta max \geq 0.236$ (formula 1)

As described in the specification on page 18, lines 30-page 19, line 7, when tan δmax is less than 0.236, the dyeability of the polyester fiber is markedly degraded and abrasion resistance is decreased. To satisfy formula 1, applicants have found that it is important that the phosphorus compound in the polyester be of a side chain type. In addition, the draw ratio can also affect tan δmax. Specifically, when the draw ratio is too high, this formula cannot be satisfied and the dyeability is degraded.

(b) $T\alpha - 3.77 \times \ln (dtpf) \leq 137.0$ (formula 2)

As described on page 19, lines 7-11, the dyeability of the polyester fiber is again degraded when this range is not satisfied. As with formulas 1, applicants have found that it is important that the phosphorus compound in the polyester be of a side chain type. In addition, if the draw ratio of the fiber is too high, this formula can not be satisfied.

(c) $1.331 \leq SG - \frac{\sqrt{\Delta n}}{8.64} \leq 1.345$ (formula 3)

This formula is described on page 19, lines 15-26, of the specification. When the value is lower than the claimed range, the molecular orientation relative to the crystallinity becomes high and the density of the amorphous part of the polyester increases. This results in inferior dyeability and abrasion resistance. Conversely, when the value is higher than this range the molecular orientation relative to the crystallinity becomes too low, resulting in a decrease in the fiber strength, an increase in the shrinkage in hot water, and a reduction of the heat stability of the polyester. Again to satisfy formula 3, it is important that the phosphorus compound be of a side chain type. In addition, the draw ratio must not be too high.

(d) shrinkage in hot water (SHW) ≤10%

As described on page 20, lines 11-17 of the specification, when the SHW exceeds 10%, the fiber shows poor heat stability resulting in considerable changes in fiber size during processing of the polyester fiber and the texture of fabric becomes rough (page 20, lines 11-17). To satisfy this formula applicants have found that the setting temperature in a drawing step affects the SHW. Specifically, it has been found that a temperature lower than 155°C results in insufficient setting, resulting in the SHW exceeding 10%.

Claim 1 also recites the following three elements (e)-(g):

(e) phosphorus atom content is 500-50,000.

(f) the fiber was melt spun at a take-up speed of 1000 - 4500 m/min in the spinning step,

(g) the fiber comprises a copolymerized polyester obtained by copolymerizing a side chain type phosphorus compound (a phosphorus compound into which a phosphorus compound can be introduced at a side chain and/or end of polyester).

The claimed flame-retardant polyester fiber is produced by melt spinning a copolymerized polyester obtained by copolymerizing a side chain type phosphorus compound (a phosphorus compound into which a phosphorus compound can be introduced at a side chain and/ or end of polyester) at the claimed take-up speed within the range of 1000-4500 m/min (see page 16, lines 9-13 of the specification). The take-up speed directly relates to the shear rate of the discharged polymer (see page 17, lines 18-29 of the specification), which is preferably between 3000-9000 s^{-1} to achieve the desired molecular orientation and to suppress fiber breakage. When the take-up speed is less than 3000 s^{-1}, the molecular orientation of the polyester in a melt state is insufficient, and the obtained fiber has low strength and poor abrasion resistance (page 17, lines 18-22).

Conversely, when it exceeds 9000 s^{-1}, an increase in fiber breakage occurs because the surface of the spinneret, particularly around orifices, is heavily stained.

II. Amendments to Claim 1

Independent claim 1 has been amended to specify that tan $\delta max \geq 0.236$. Claim 1 has also been amended to specify that in a yarn abrasion test the number of times before fiber breakage under a load of 0.098 N/tex is not less than 7720 times. Both of these amendments are supported by the Examples summarized in Table 1, on page 37. Examples are given for tan δmax being equal to and greater than 0.236. In addition, examples are given for the abrasion resistance being equal to and greater than 7720 times. Claim 3 has been cancelled. As explained below, these amendments further clarify the differences between the cited prior art and the claimed invention.

III. Comparison with Leumer

Leumer discloses a low flammability polyester fiber using a phosphorus compound copolymerized polyester. However, the low flammable polyester fiber disclosed by Leumer does not satisfy formulas (1)-(3) of claim 1 of this application. Namely, the low flammable polyester fiber disclosed by Leumer is intended to be used for tarpaulins (tents, fences for architecture and the like) and as a sheet-like reinforced material (tire cord, conductive belt cord, reinforcing layer of a conveyor belt and the like) (see Leumer, column 1, lines, 12-23). For these applications, Leumer states that the fiber has an extremely high tenacity and has a specific dry heat shrinkage (see, for example, Leumer claims 4-6). Further, to obtain the high strength required for these applications (over 65 cN/tex or over 75 cN/tex), the fiber is drawn at an extremely high draw ratio (the total draw ratio of in a two step draw is 4.5-6.0 fold). Finally Leumer describes the use of a copolyester

obtained by copolymerizing a main chain phosphorus compound to enhance crystallinity and molecular orientation of the fiber.

Unlike Leumer, applicants specifically claim a copolymerized polyester comprising a phosphorus atom in a side chain. As described on page 2, lines 12-21 of the application, when a phosphorus atom is present in the main chain polyester, a fiber obtained by spinning such a polyester results in poor dyeability, and the fabric produced therefrom shows poor texture.

In addition, a high draw ratio during production leads to degraded dyeability and lower abrasion resistance of the fiber as mentioned above. Accordingly, in the examples in the specification the highest draw ratio utilized is 2.8 fold. Leumer discloses a much higher draw ratio, which effects the fiber characteristics listed in claim 1. Specifically, as explained above, applicants satisfied formulas (1)-(3) of claim 1 by using a phosphorus compound copolymerized polyester comprising a phosphorus atom in a side chain and by using a acceptable draw ratio. Since Leumer does not disclose using a phosphorus compound copolymerized polyester comprising a phosphorus atom in a side chain and utilizes a much higher draw ratio than applicants, the fiber in Leumer would not inherently comply with formulas 1-3 in claim 1.

Further, Comparative Example 6 actually shows that when a fiber is made from a polyester made from a copolyester obtained by copolymerizing a main chain phosphorus compound as a starting material, like the low flammable polyester fiber disclosed by Leumer, formula (3) was not satisfied. In addition, in Comparative Example 6 tan δmax is less 0.230, which fails to satisfy formula 1 as amended. Finally, in Comparative Example 6, the abrasion resistance of the yarn in the yarn abrasion test was 6403 times, which is less than the claimed 7720 times.

Please note that the polyester fiber disclosed in Leumer would probably perform even worse than Comparative Example 6 since the high draw ratio utilized in Leumer would further degrade the test results.

IV. Comparison with Tashiro

Tashiro discloses a technique for imparting flame-retardance to cloth by treating the cloth with an aqueous solution containing a phosphorus compound. Tashiro does not describe or suggest the phosphorus compound copolyester as claimed. Further, Tashiro also fails to describe a flame-retardant polyester fiber obtained by melt spinning such a phosphorus compound polyester. Therefore, the polyester fiber of the present invention, which is obtained by melt spinning a phosphorus compound copolyester, and the woven or knitted fabric and nonwoven fabric obtained from the claimed fiber, are not described or suggested by Tashiro.

Further, the combination of Tashiro with Leumer would not result in the claimed invention since, as explained above, Leumer does not disclose a fiber with a phosphorus compound copolymerized polyester including a phosphorus atom in a side chain and does not disclose a polyester fiber that would satisfy the characteristics recited in claim 1.

V. Comparison with Vogt

The Examiner only cites Vogt as showing a method of making a polyurethane suede-like material. Vogt fails to disclose or suggest the flame-retardant polyester fiber recited in claim 1.

VI. Comparison with Buxbaum

The Examiner cites Buxbaum to show a process for manufacturing a linear polyester containing phosphates suitable for use in the form of a filament. In Buxbaum, the phosphorus compound is used to accelerate the polymerization rate. However, the phosphorus compound is

subject to linear copolymerization, namely, main chain copolymerization. Buxbaum does not describe or suggest melt spinning a copolyester obtained by copolymerizing a side chain phosphorus compound to give a polyester fiber as claimed.

Since Leumer, Tashiro, Buxbaum and Vogt, alone or in combination, fail to disclose or suggest the claimed polyester fiber including a phosphorus compound copolymerized polyester with a phosphorus atom in a side chain and fail to disclose a polyester fiber possessing all of the claimed characteristics, claims 1, 2, 4, and 6-12 should be allowed.

In view of the above, each of the presently pending claims in this application is in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue. If it is determined that a telephone conference would expedite the prosecution of this application, the Examiner is invited to telephone the undersigned at the number given below.

In the event the U.S. Patent and Trademark office determines that an extension and/or other relief is required, applicant petitions for any required relief including extensions of time and authorizes the Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to Deposit Account No. 03-1952 referencing Attorney Docket No. 358362010400.

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Respectfully submitted,

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